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KOKAI (Japanese Unexamined Patent Publication) No. 59-143032

Title of the Invention: Surface-Hardened Pt Alloy Material for Jewelry

Publication Date: August 16, 1984

Patent Application No. 58-17086

Filing Date: February 4, 1983

## SPECIFICATION

### 1. Title of the Invention.

Surface-hardened Pt alloy material for jewelry

### 2. Scope of Claim for Patent

(1) A surface-hardened Pt alloy material for jewelry comprising the formation of a surface-hardened layer, having a structure in which hard chromium boride is dispersed, on the surface of a Pt alloy material having a composition that contains 0.5 to 15% by weight of Cr, with the remainder consisting of Pt and unavoidable impurities.

(2) A surface-hardened Pt alloy material for jewelry comprising the formation of a surface-hardened layer, having a structure in which hard chromium boride is dispersed, on the surface of a Pt alloy material having a composition that contains 0.5 to 15% by weight of Cr and 0.5 to 25% by weight of Pd, with the remainder consisting of Pt and unavoidable impurities.

(3) A surface-hardened Pt alloy material for jewelry comprising the formation of a surface-hardened layer, having a structure in which hard chromium boride is dispersed, on the surface of a Pt alloy material having a composition that contains 0.5 to 15% by weight Cr and 0.5 to 15% by weight of one or more types selected from Cu, Ag, Ni, Co, Fe, Au and Ir, with the remainder consisting of Pt and unavoidable impurities.

(4) A surface-hardened Pt alloy material for jewelry comprising the formation of a surface-hardened layer, having a structure in which hard chromium boride is dispersed, on the surface of a Pt alloy material having a composition that contains 0.5 to 15% by weight of Cr, 0.5 to 25% by weight of Pd, and 0.5 to 15% by weight of one or more types of Cu, Ag, Ni, Co, Fe, Aug and Ir, with the remainder consisting of Pt and unavoidable impurities.

### 3. Detailed Description of the Invention

The present invention relates to a Pt alloy material for jewelry such as rings and necklaces that has remarkably high surface hardness, and therefore demonstrates superior abrasion resistance during actual use.

As is commonly known, Pt is one of the most stable metals along with Au, and in addition to retaining a beautiful metallic luster over a long period of time, is extremely soft, has superior malleability, and coupled with its ease of working,

is widely used as a jewelry material in the same manner as Au.

In addition, since Pt is extremely soft, it is easily scratched. Thus, Pt alloys that have been given suitable hardness by containing as alloy components metals such as Cu, Ag, Ni, Co, Fe, Au or Ir are used practically in the form of platinum 950, platinum 850 and so forth.

However, in the case of wearing these Pt alloys as accessories, they are easily scratched and their metallic luster deteriorates comparatively quickly.

Moreover, although rings and necklaces containing distinct patterns produced by fine cutting using the so-called diamond method have recently become popular, due to the softness of conventional Pt alloys, there is frequently the problem of the edges becoming worn or the pattern becoming indistinct. Thus, there is a strong demand for a hard Pt alloy with respect to these points as well.

In general, when Pt alloy materials are worn as accessories, the surface hardness (Vickers hardness, Hv) of the Pt alloy material should be 400 or more, and preferably 500 or more. For example, since the hardness of the watch dial glass of wristwatches has an Hv value of about 500, if a Pt alloy were able to have a hardness of 500 or more, then it would be possible to provide a Pt alloy watch having a watch dial glass that is resistant to scratching.

However, even if heat treatment is performed on various Pt alloys or processed hardening is used, the resulting hardness has conventionally been 350 at best, and a hard Pt alloy material that satisfies the above requirements has yet to be obtained.

Therefore, as a result of conducting studies to obtain a Pt alloy material having suitable hardness, and particularly high surface hardness, in consideration of the aforementioned requirements, the inventors of the present invention found that when boronation treatment is carried out on the surface of a Pt alloy material having a composition that contains, as percent by weight, 0.5 to 15% of Cr, and 0.5 to 25% of Pd and/or 0.5 to 15% of one or more types of Cu, Ag, Ni, Co, Fe, Au and Ir, as necessary, with the remainder consisting of Pt and unavoidable impurities, since the B that has diffused and penetrated through the surface mainly reacts with Cr dissolved in the substrate resulting in the formation of extremely hard chromium boride, a surface-hardened layer is formed on the surface of the Pt alloy material that has a structure in which hard chromium boride is dispersed, and since the resulting surface hardness value Hv is extremely high at 1000 to 1500, the surface-hardened Pt alloy material demonstrates extremely superior abrasion resistance, and is able to retain its beautiful metallic luster semi-permanently.

This invention was completed on the basis of the

aforementioned finding, and is a surface-hardened Pt alloy material for jewelry comprising the formation of a surface-hardened layer, having a structure in which hard chromium boride is dispersed, on the surface of a Pt alloy material having a composition that contains:

0.5 to 15% by weight of Cr, and as necessary,

0.5 to 25% by weight of Pd and/or,

0.5 to 15% by weight of one or more types of Cu, Ag, Ni, Co, Fe, Au and Ir, with the remainder consisting of Pt and unavoidable impurities.

The following provides an explanation of the reasons for limiting the ranges of the component compositions in the Pt alloy material of this invention as described above.

(a) Cr

In addition to dissolving in the substrate and strengthening it, the Cr component has the action of forming hard chromium boride as a result of carrying out boronation treatment on the material, thereby enhancing its surface hardness and significantly improving abrasion resistance. However, if the content of Cr is less than 0.5% by weight, it is not possible to form a surface-hardened layer having the desired high degree of hardness. On the other hand, if Cr is contained in excess of 15% by weight, the plastic processability of the material itself tends to deteriorate, and since effects

that further improve the hardness of the surface-hardened layer cannot be expected, the content of Cr is defined to be 0.5 to 15% by weight.

(b) Pd

Since the Pd component has the action of improving the ductility of the Pt alloy material, it is contained as necessary particularly in cases when ductility is required. However, if the content of Pd is less than 0.5% by weight, the desired effect of improving toughness is unable to be obtained. On the other hand, since corrosion resistance decreases if contained in excess of 25% by weight, the content of Pd is defined to be 0.5 to 25% by weight.

(c) Cu, Ag, Ni, Co, Fe, Au and Ir

Since these components have the action of strengthening the Pt alloy material, they are contained as necessary in cases when strength is required in particular. However, the desired strength cannot be achieved if their content is less than 0.5% by weight. On the other hand, if they are contained in excess of 15% by weight, since ductility decreases resulting in difficulty in plastic processing, their content is defined to be 0.5 to 15% by weight.

The following provides a more detailed explanation of the Pt alloy material of this invention through its examples.

Examples

After producing 10 g each of the Pt alloy melts having the component compositions respectively shown in Table 1 by melting the required alloyed metals and electrolytic Pt in a steel water-cooled crucible using a TIG arc welder, the melts were cast in a metal mold in the shape of buttons followed by polishing the surfaces to obtain test pieces having a surface area of 10 mm x 10 mm and a height of 1 mm. After carrying out boronation treatment by immersing for 8 hours in molten flux (composition in percent by weight: B<sub>4</sub>C: 80%, H<sub>3</sub>PO<sub>3</sub>: 10%, Na<sub>2</sub>B<sub>4</sub>O<sub>7</sub>: 10%) maintained at 800° by preheating and melting in a graphite crucible, the test pieces were removed into the atmosphere to respectively produce Pt alloy materials 1 to 27 of the present invention and comparative Pt alloy materials 1 to 8.

Table 1-1

Material Type		Component Composition (wt%)										Max. surface hardness	
		Cr	Pd	Au	Ag	Cu	Ir	Ni	Fe	Co	Pt	Before boronation treatment	After boronation treatment
Pt alloy materials of the present invention	1	0.53	-	-	-	-	-	-	-	-	Rem.	80	520
	2	14.9	-	-	-	-	-	-	-	-	Rem.	180	1330
	3	10.3	0.61	-	-	-	-	-	-	-	Rem.	150	1335
	4	5.0	24.5	-	-	-	-	-	-	-	Rem.	120	1060
	5	8.0	-	0.60	-	-	-	-	-	-	Rem.	135	1200
	6	8.3	-	14.3	-	-	-	-	-	-	Rem.	270	1250
	7	8.2	-	-	0.61	-	-	-	-	-	Rem.	145	1200
	8	8.3	-	-	14.9	-	-	-	-	-	Rem.	250	1310
	9	8.3	-	-	-	0.62	-	-	-	-	Rem.	132	1290
	10	8.4	-	-	-	14.8	-	-	-	-	Rem.	190	1300
	11	8.4	-	-	-	-	0.55	-	-	-	Rem.	121	1280
	12	8.5	-	-	-	-	14.9	-	-	-	Rem.	230	1290
	13	8.4	-	-	-	-	-	0.60	-	-	Rem.	122	1280
	14	8.4	-	-	-	-	-	14.5	-	-	Rem.	300	1380
	15	8.4	-	-	-	-	-	-	0.53	-	Rem.	128	1290

	16	8.4	-	-	-	-	-	-	14.3	-	Rem.	260	1300
	17	8.4	-	-	-	-	-	-	-	0.61	Rem.	133	1270
	18	8.5	-	-	-	-	-	-	-	14.3	Rem.	265	1330
	19	8.5	10.0	10.1	-	-	-	-	-	-	Rem.	200	1300
	20	8.5	10.2	-	10.5	-	-	-	-	-	Rem.	190	1260

Table 1-2

Material Type		Component Composition (wt%)										Max. surface hardness	
		Cr	Pd	Au	Ag	Cu	Ir	Ni	Fe	Co	Pt	Before boron-ation treat-ment	After boron-ation treat-ment
Pt alloy materials of the present invention	21	8.5	10.1	-	-	9.3	-	-	-	-	Rem.	193	1330
	22	8.5	-	-	-	-	9.8	-	-	-	Rem.	200	1310
	23	8.5	10.1	-	-	-	-	10.1	-	-	Rem.	233	1300
	24	8.5	13.2	-	-	-	-	-	10.1	-	Rem.	230	1330
	25	8.5	10.2	-	-	-	-	-	-	9.3	Rem.	223	1303
	26	8.3	10.0	1.1	1.2	1.0	1.0	1.1	1.0	1.0	Rem.	205	1290
	27	9.0	10.2	3.1	3.0	3.1	2.0	0.9	1.1	1.0	Rem.	240	1310
Comparative Pt alloy materials	1	-	-	10.1	-	-	-	-	-	-	Rem.	180	180
	2	-	-	-	10.0	-	-	-	-	-	Rem.	130	133
	3	-	-	-	-	10.1	-	-	-	-	Rem.	140	144
	4	-	-	-	-	-	10.0	-	-	-	Rem.	160	160
	5	-	-	-	-	-	-	10.1	-	-	Rem.	230	225
	6	-	-	-	-	-	-	-	10.0	-	Rem.	220	210
	7	-	-	-	-	-	-	-	-	10.2	Rem.	225	220
	8	-	10.1	2.9	3.1	3.0	2.1	0.9	1.0	1.1	Rem.	220	222

Next, the maximum surface hardness (Vickers hardness) of each type of resulting material was measured. Those results are shown in Table 1. Furthermore, both the maximum hardness values before and after boronation treatment are shown in Table 1.

Furthermore, comparative Pt alloy material 1 to 8 were obtained by carrying out boronation treatment on conventionally known Pt alloys.

Based on the results shown in Table 1, all of the Pt alloy members 1 to 27 of the present invention demonstrated even

better surface hardness as a result of boronation treatment, and exhibited extremely high surface hardness as indicated by Hv values of 500 or higher. In contrast, in the comparative Pt alloy materials 1 to 8 that did not contain Cr, since there was no formation of a surface-hardened layer having a structure in which hard chromium boride was dispersed even following boronation treatment, there was clearly any change in their surface hardness.

As has been described above, since a Pt alloy material of this invention has a surface-hardened layer comprised of a structure in which hard chromium boride is dispersed, in the case of using as jewelry, it has industrially useful characteristics such as being able to maintain its original form over an extremely long period of time without losing its aesthetic value.

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